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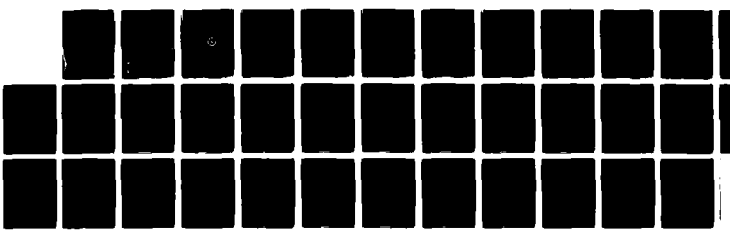

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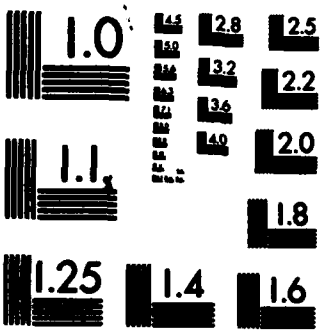

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document describes the broad, achievable requirements for accomplishing the relevant STARS objectives. Its main purpose is to help guide the implementation planning process. It is one of eight functional task area strategies produced by the STARS Joint Task Force. In order to provide full understanding, background and rationale material is sometimes covered that is also in the STARS Program Strategy.

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SOFTWARE TECHNOLOGY FOR ADAPTABLE RELIABLE SYSTEMS (STARS) FUNCTIONAL TASK AREA STRATEGY FOR HUMAN RESOURCES

Department of Defense

30 March 1983

FOREWORD

This strategy document is one of eight functional task area strategies produced by the STARS Joint Task Force. All of the documents produced by the Task Force, including the general STARS Program Strategy document, are listed in the STARS Joint Task Force Report.

This document identifies the scope, sub-objectives and strategies designed to provide the conceptual approach for accomplishment of the STARS Program objectives in the human resources functional task area. It identifies and describes the high-level activities, products and capabilities. In order to provide full understanding, background and rationale material is sometimes covered that is also in STARS Program Strategy.

These functional task area strategy documents do not attempt to delineate the detailed plans, costs and procedures for bringing the proposed products and capabilities into being and do not identify the form of the particular projects that will undertake the work nor the organizations in which the work will be accomplished. Instead, these strategies are intended to guide the process of such implementation planning and accomplishment.

Indeed, because of the high degree of linkage among the functional task areas, implementation plans and acquisitions may well combine related capabilities and products across areas. Individual projects may tackle only part of one subtask from a functional area or several subtasks from several functional areas.

Thus, this functional task area strategy describes broad, achievable requirements for accomplishing the relevant STARS objectives. Its main purpose is to help guide the implementation planning process.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

1.0 OVERVIEW

1.1 Scope of the Task Area

The primary objective of the human resources task area is to improve personnel resources. This primary objective is based on the two objectives, increase the level of expertise and expand the base of expertise available to DoD. An interesting aspect of motivation behind the human resources task area can be noted in [4] as follows:

> "It's ironic," the manager said. "More companies spend 50% to 70% of their money on people's salaries. And yet they spend less than 1% of their budget to train their people. Most companies, in fact, spend more time and money on maintaining their buildings and equipment than they do on maintaining and developing people."

This task area is a direct attack by DoD and industry on improving human resources within the software field. Broadly stated, the objectives would be satisfied by defining software-related job knowledge, skills, and abilities; software-related education and training. The target audience includes personnel in software engineering and management.

The human resources task area interacts with a number of the other task areas. Educational products produced through the human resources task area would be utilized for example by the SEI. Quantitative skill level requirements based on educational units and task period performance must serve as inputs to the measurement task area. These quantitative measures should also be used for evaluation within the task area. In addition, the measures serve as input to the acquisition and project management task areas. Outputs generated by the acquisition and project management areas would serve to improve the human resources task area. The human engineering, support systems and application specific task areas would be assisted by human resources area funding of advanced learning aids.

1.2 Strategy

The DoD personnel situation is a multi-faceted area that includes: people, organizations, and regulations. People include those software-related personnel within the DoD community, i.e., civil service, military, and industry. Organizations include those groups that perform software development, maintenance, acquisition management and those that provide software training education. In addition, the professional computing societies provide a forum for minimizing technical obsolescence. Regulations concerning personnel, training, and software acquisition control the outputs of the human resources area.

The objective, "increase the level of expertise" predisposes the determination of existing software-related positions and career structures within the DoD community. Job position and career structure descriptions produced by the human resources area would serve as recommendations for DoD personnel but there is concern within the DoD community that the existing personnel system does not adequately address software personnel. We emphatically note that in no way are the position/career related aspects to be misconstrued as an attempt to force change in the DoD personnel system.

Based on baseline skills studies, the "increase and expand" objectives can be approached through exchange programs, academic, and continuing education programs. As noted earlier in this document, the other task areas are expected to "improve power of tools" and "increase use of tools," in terms of the overall objective "improve environments." The human resources area is expected to ensure that personnel will make effective use of the technical advances made in the improvement of the tools. "Most failures can be directly related to inadequate training of both management and technical staff," was noted by Joan Carter, GE, a member of "A Panel on Software Engineering Education," at the Sixteenth Annual Hawaii International

Conference on System Sciences, January 5-7, 1983. This task area should attempt to minimize potential DoD software engineering and management failures through an extensive education and training program.

2.0 STRATEGY DETAILS

2.1 Major Subtasks

The human resources area consists of six major subtask areas related to personnel and education. Software-related personnel subtask areas include: 1) assessment of key populations, 2) career structures, incentives and mechanisms, and 3) exchange programs. Software-related education/training subtask areas include: 1) education programs, 2) training programs, and 3) learning aids. Figure 1 is the subtask outline of the human resources area. Figure 2 is a milestone chart of the human resources subtasks. Figure 3 is the expected intertask area liaison that is further elaborated in the next section.

- HUMAN RESOURCES
  - PERSONNEL
    - ASSESSMENT OF KEY POPULATIONS
      - NEAR TERM
        - DEFINE
          - SKILLS
          - UTILIZATION
      - LONG TERM
        - IDENTIFY
          - REQUIREMENTS
            - QUALITATIVE/QUANTITATIVE DESCRIPTIONS
            - PERSONNEL NUMBERS
            - FUTURE NEEDS
    - CAREER STRUCTURES
      - NEAR TERM
        - STRUCTURES
        - UPGRADE
      - LONG TERM
        - CERTIFICATION
        - REVIEW PANEL
    - EXCHANGE PROGRAMS
      - NEAR TERM
        - UTILIZATION
      - LONG TERM
        - ENHANCED UTILIZATION
        - DOD PERSONNEL/ACADEMIA EXCHANGES
  - EDUCATION/TRAINING
    - EDUCATION PROGRAMS
      - WORKSHOP AND CURRICULA TAILORING
      - EVALUATE, PROMULGATE, AND IMPROVE CURRICULA
      - SELECT AND PROVIDE SUPPORT
      - EDUCATIONAL FINANCIAL ASSISTANCE PROGRAM
    - TRAINING PROGRAMS
      - PLANNING
      - COORDINATING
      - ADA/APSE COURSES
      - NON-ACADEMIC COURSES
    - LEARNING AIDS
      - RESPONSIBILITY
      - SURVEY EXISTING TECHNOLOGY
      - PROTOTYPE
      - LONG TERM
        - EVOLVE PROTOTYPE

FIGURE 1: Human Resources Area Subtask Outline

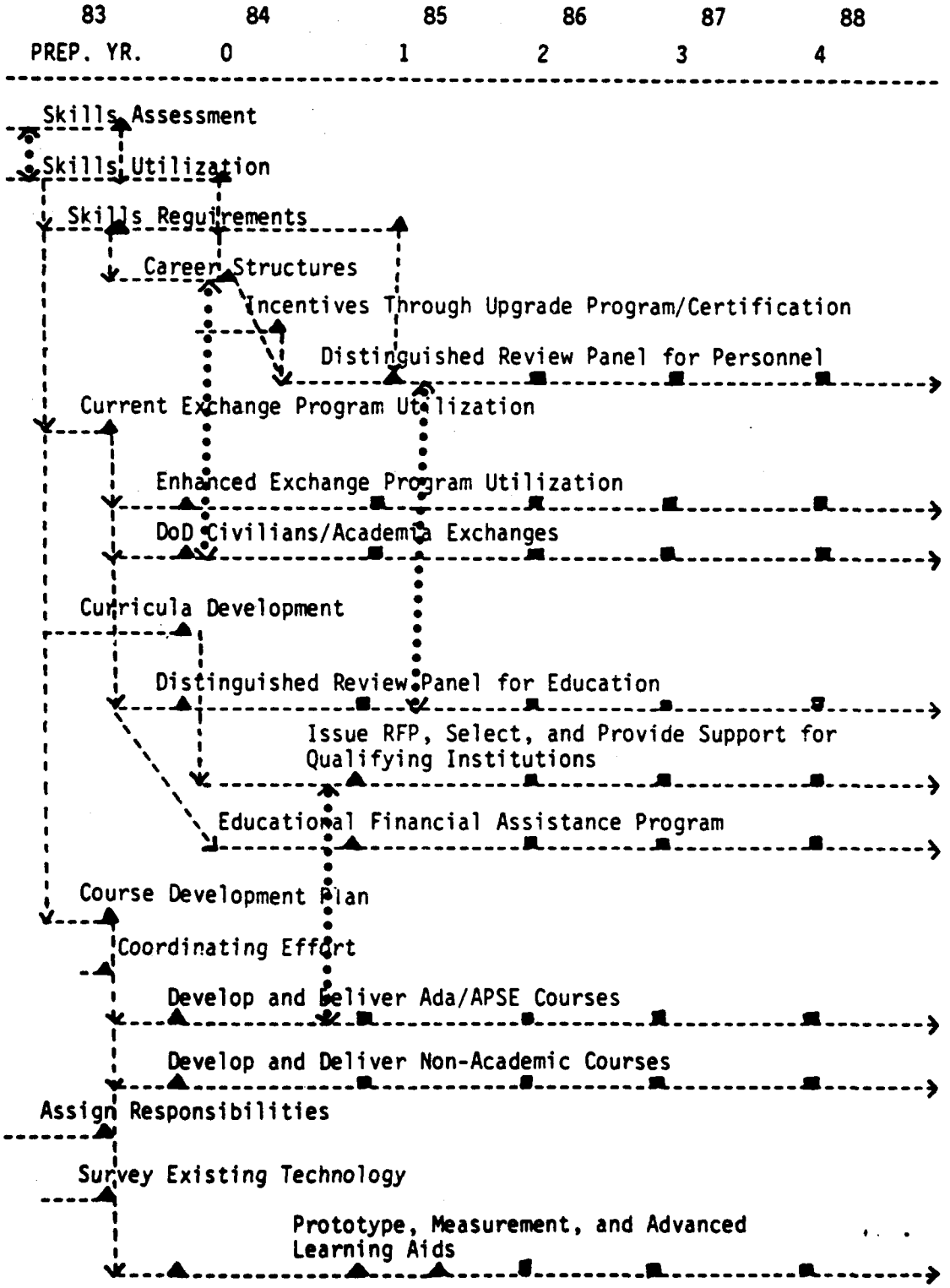

Figure 2: Human Resources Tasks Milestone Chart

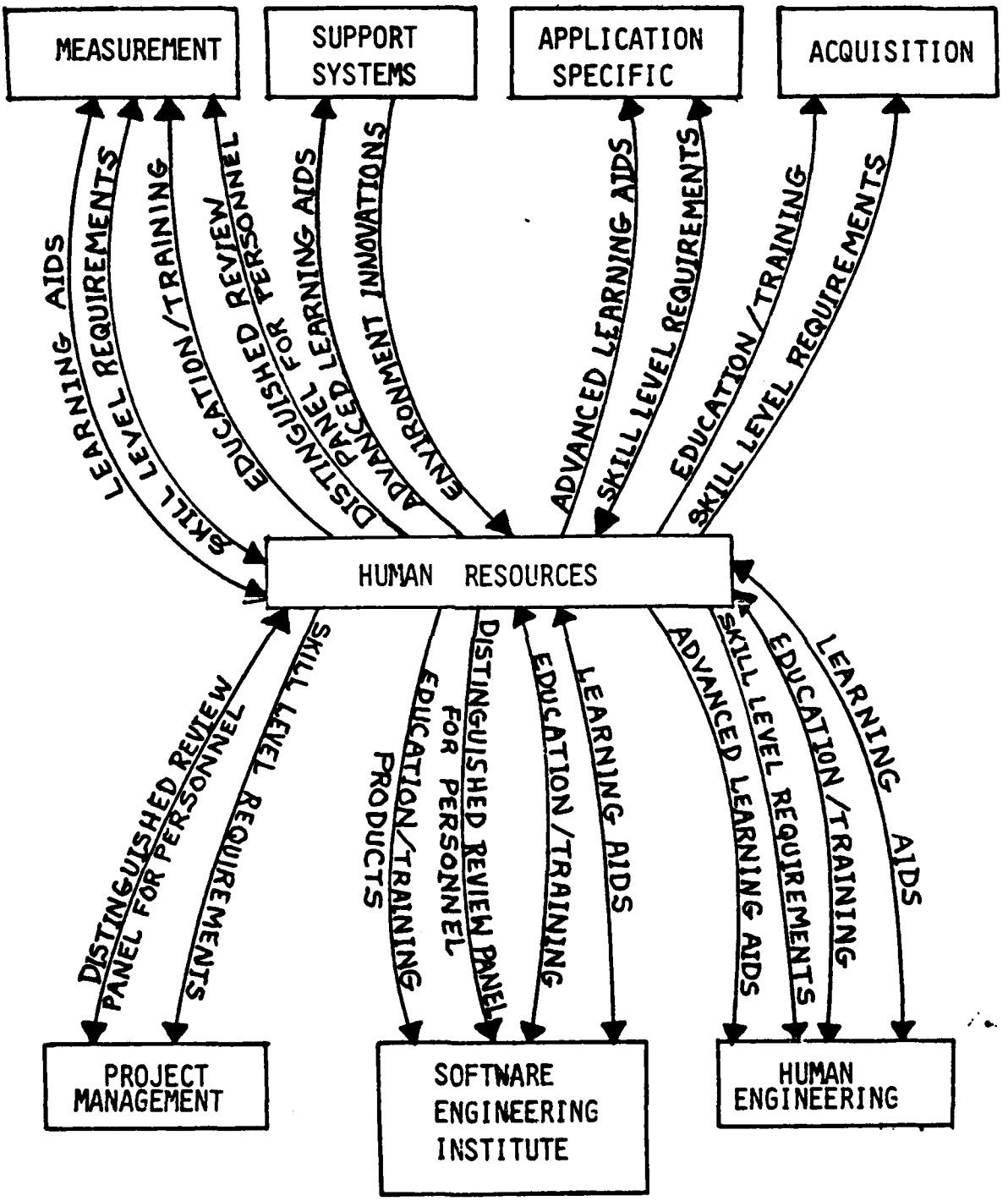

FIGURE 3: Intertask Liaison Area

2.2 Detailed Activities

This section is an overview of the detailed activities which should be performed in the human resources task area. A further decomposition is included for each of the six major subtask areas discussed in the previous section.

2.2.1 Assessment of Key Populations

2.2.1.1 Purpose. This subtask area is required as front-end work for the career structures, course development, and education/training program subtask areas. The purpose of this subtask area is to assess software-related skills and utilization within the DoD community. Three major subtasks are integral to the assessment of key populations subtask area: 1) define skills, 2) skills utilization, and 3) identify requirements.

2.2.1.2 Inputs. There are three primary inputs to this subtask area: 1) personnel backgrounds, 2) personnel records, and 3) personnel regulations. A rather broad survey has already been conducted in academia [6] to address utilization of recent University of Florida graduates. Another recent study performed by SofTech, Inc. [24], under contract to the U.S. Army Communications-Electronics Command was a partial attempt to address this subtask area. As part of the contract effort, an Industry/Government Work Force Survey was administered to several DoD contractors and Army organizations. Currently in process is a Navy Sponsored Office of Personnel Management (OPM) Software Engineering Occupational Study which will investigate the needs for civil service positions in software engineering. This subtask area would broaden the scope of inputs to include the software-related DoD community consisting of civil service, military (all branches of service), and industry.

2.2.1.3 Description. An initial subtask should be to investigate the types and quality of software-related skills of personnel within the DoD community. This assessment should be people-oriented in terms of data collection obtained through survey. Personnel records and regulations are too sparse for the purpose of this subtask but can be included to augment the collected data.

Concurrent with the skills assessment should be a subtask to investigate the utilization of DoD personnel with software-related skills. This study is twofold: investigate percent utilization and performance of job tasks. A study of this nature would use the three primary inputs of backgrounds, records, and regulations.

The final subtask should be to develop for each position skill requirement descriptions and numbers of personnel based on the two above mentioned investigations. Quantitative aspects of the requirements would be based on educational units and/or task period performance. The educational units should include criteria related to subject matter content and level of mastery. The task period performance measures should include well-defined software engineering and management items, as well as grade/rank information. Job position descriptions produced by this subtask would result in recommendations for potential incorporation in the DoD. The qualification/classification guidelines produced by this subtask must be consistent with existing DoD personnel regulations. These job position descriptions would encompass skill requirements for software development, maintenance, acquisition, and management. In addition, future personnel requirements (both skills and numbers) would be identified in this subtask, one candidate is that of a Human Factors Engineer (software) who could provide valuable information relative to the human interface with the software and hardware over a systems lifecycle.

2.2.1.4 Coordination. The assessment key population area subtasks provide forward coordination within the human resources task area to the career structures and education/training subtask areas. In addition, the outputs of these subtasks are to serve as input to the acquisition, human engineering, measurement, and project management task areas.

2.2.1.5 Outputs. Three outputs should be produced by this subtask area. An assessment of types and quality of software-related skills would indicate the current status of the DoD community. The second study would provide information on the quantity and quality of DoD community personnel utilization. Finally, the skill requirements study would produce classification guidelines based on knowledge, skills, and abilities for the DoD community throughout the software life cycle.

2.2.1.6 Cost Factors. By utilizing recently completed and ongoing related study efforts the skills assessment study should be performed in nine months. The skills utilization study should be performed concurrently with the skills assessment study. The skills requirements study should be performed partially concurrent and after the assessment and utilization studies have been completed for a period of fifteen months.

2.2.1.7 Benefit. The assessment of key populations subtask area would provide quantitative information concerning software-related personnel within the DoD community. It is critical that software engineers and managers upgrade skills and keep from becoming technically obsolete. It is equally important that a personnel system be established that provides quantitative skill level requirements that can be achieved by personnel.

This subtask effort is not designed to force the services to adhere to a strict personnel structure. Instead, the outputs of this

subtask area should serve as recommendations or suggestions for the services and other DoD components.

2.2.1.8 Schedule. The milestone chart in Figure 2 indicates the concurrency of the initial investigation subtasks to determine the current utilization of software personnel. The third subtask to define skills requirements follows the initial investigation subtasks.

2.2.2 Career Structures, Incentives, and Mechanisms

2.2.2.1 Purpose. This subtask area chronologically follows the assessment of key populations subtask area. The purpose of this subtask area is to integrate and evolve the job position descriptions provided in the previous subtask area. The integration of the job position descriptions would provide career paths for civil service, military and industry personnel. Due to the nature of the personnel problem, these career path descriptions should serve as recommendations to the services and agencies. Evolution of DoD implementation of the career paths should be aided by a distinguished panel of reviewers. Incentives and skills upgrading programs should be implemented to assist this process.

2.2.2.2 Inputs. There are three primary inputs to the career paths subtask area. The first input mentioned above is the set of job position descriptions provided in the previous subtask area. The second input is the set of existing career paths that are available in the DoD community. The final input is the results of the Navy Sponsored OPM Software Engineering Occupational Study.

The incentives subtask has as inputs the existing DoD incentive program, the Certificate of Data Processing, and professional engineer licensing procedures.

2.2.2.3 Descriptions. The first major subtask should be the development of career structures for the DoD community. The career structures must be developed to be easily incorporated within the existing military services and civil service personnel systems. Quantitative skill level measures based on educational units and/or task period performance will be used for advancement in the career path plans. There could be difficulty in implementing dual ladders (technical and managerial) within the military. This subtask must also investigate the impact of dual career tracks (e.g., software engineering and infantry) within the military.

The second major subtask should be the development of a plan for career enhancing incentives. Initially this subtask should establish a program to upgrade the skills of software-related personnel to meet job position descriptions. In addition, this subtask should study the possibility of retraining individuals into the software engineering career paths. This investigation should also develop career enhancing incentives that would aid in upgrading personnel. The professional computing societies serve as an excellent forum for this area. Participation in the societies should be coupled in a quantitative manner to career advancement. The possibilities for participation are numerous, e.g., membership, conference/journal referee, technical meeting attendee, technical article author, technical meeting committee member/chairman, editor, technical meeting session/track leader, panelist, technical committee member/chairman, distinguished visitor/national lecturer, and society officer. Finally, a workshop should be held to address the area of certification. This workshop should have the objectives of defining current professional certification and licensing procedures, defining the characteristics of a software engineering certification/licensing procedure, and providing direction for implementing such a procedure. The area of certification has been discussed in terms of computer

science and engineering in [2, 19], and certification examinations for data processing managers and senior programmers are currently offered by the Institute for Certification of Computer Professionals. The results of the workshop should be followed by the development of a software engineering certification procedure to be handled in a manner similar to certification of professional engineers.

The last subtask to be performed should be the formation of a distinguished panel of reviewers to evaluate, improve, and revise career related elements. The reviewers should be selected from the DoD, industry, and academia. The panel would initially develop quantitative criteria to support an evaluation of the career path implementation. Guidance would be provided to the services and agencies in implementing the recommended career path structures. It is most important to develop a systematic means for feedback from DoD personnel. The review panel should participate in this feedback process, as well as the incentives program.

2.2.2.4 Coordination. The distinguished review panel should coordinate with the education and training program subtask areas. In addition, continuous interaction is expected between the review panel and the Software Engineering Institute, measurement, and project management task areas.

2.2.2.5 Outputs. Four major outputs are produced by this subtask area. The first output is a set of career paths recommended for implementation in the DoD. The career path descriptions would contain quantitative measures that DoD personnel can seek to achieve. The second output is an incentive program that is also coupled with participation in the professional computing societies. The third output would result in a certification procedure for DoD software personnel. The final output is a review panel to monitor the evolution of career related elements.

2.2.2.6 Cost Factors. The career path development is expected to be performed in a nine month period. A program should be established to upgrade skills including certification and development of the certification procedures. The review panel should be allocated resources to be used in administration and incentives.

2.2.2.7 Benefit. This subtask area would provide the DoD with a set of preferred career structures. The individual services and agencies could tailor and implement the career structures as appropriate. A distinguished review panel should assist the services and agencies with guidance in implementing the career structures. The services should monitor the personnel systems to improve the effective utilization of DoD personnel with software-related skills. In addition, the services would be responsible for administering the incentives program. Certification procedures would be used to measure personnel with software-related skills and to motivate employees to maintain and acquire new skills.

2.2.2.8 Schedule. The milestone chart in Figure 2 indicates that career structure development is the lead subtask for this area. The incentives program should be defined before the initiation of the review panel. The review panel should begin in FY85 to be maintained through FY88.

2.2.3 Define and Implement Exchange Programs

2.2.3.1 Purpose. The exchange program subtask area is designed to increase the dual flow of software-related personnel across DoD and industrial/academic organizations. The purpose of the exchange program is to allow DoD personnel to work in temporary positions within industry and academia. This program also allows the reverse situation of industry and academia personnel to work within DoD. In addition, the exchange program would serve as a means for providing

expertise to the Software Engineering Institute. These exchanges will be defined for three month to two year positions.

2.2.3.2 Inputs. Regulations already exist for exchange programs between DoD and state organizations e.g., a state university professor on leave to a military organization. The Intergovernmental Personnel Act would be the governing regulation for implementing this type of exchange program. The Federal Personnel Manual, Schedule A, Section 213.3102 describes a variety of co-op and intern programs for students and faculty. Organizations that currently utilize the exchange program are other sources of input.

2.2.3.3 Description. The exchange program subtask area has a threefold effort. Initially, there should be an effort to further publicize the exchange program inside and outside the DoD. The second effort should investigate current utilization of the exchange program within DoD organizations. In addition, this effort would develop and implement a plan for enhanced utilization of the exchange program. The third effort is the development and implementation of a plan for DoD personnel to perform teaching/ research within universities. A competitive process should be developed for selecting DoD personnel and academic institutions. A mini-research proposal developed by the applicants should be used in a screening process for matching potential candidates with the universities.

2.2.3.4 Coordination. The career structures subtask area should coordinate with the exchange program subtask area. The Software Engineering Institute would be expected to make extensive use of the exchange program on the basis of three, six, and twelve month appointments.

2.2.3.5 Outputs. The primary output of the subtask area is an increased flow of personnel between DoD and industry/academia. DoD

personnel would be expected to perform software engineering research during exchange visits to academia.

2.2.3.6 Cost Factors. The further publication effort and current utilization study should be performed in a six month period. The program for DoD civilian personnel to visit universities would be funded. It is expected that the research program of DoD personnel include normal grant support items, e.g., graduate assistant salaries, secretarial support, computer resources, travel, and overhead.

2.2.3.7 Benefit. The major subtask benefit is the increased personnel exchange between DoD organizations and industry/academia. It is well known that industry demand for personnel with software-related skills is creating a difficult hiring situation for academia. DoD personnel in visiting positions would aid in minimizing the academic personnel shortage. The plan includes funding for approximately 12 to 15 DoD personnel in teaching/research university positions. Finally, the exchange program would allow for a better understanding in the DoD community of the approaches to software engineering.

2.2.3.8 Schedule. The milestone chart in Figure 2 indicates the current utilization study which would be followed by enhanced utilization of the exchange program.

2.2.4 Education Programs

2.2.4.1 Purpose. This subtask area is designed to increase and enhance the software engineering education that is performed in academia. The January 1983 issue of Computer included two news items related to the current engineering faculty shortage crisis. A task force of the American Association of Engineering Societies recommended that the Federal government invest $467 million in the next

ten years towards the crisis. The task force recommendations included a new faculty assistance program, White House engineering fellowships, and White House engineering professors (to entice engineers from industry to academia). The second news item described a Hewlett-Packard announcement to invest approximately $6 million in the next eight years. Funds are for selected graduate students to complete doctoral programs and then pursue full-time engineering faculty positions. The Electronics Education Foundation of the American Electronics Association is coordinating the funding effort. Although independent of this subtask area, these efforts indicate what can be done by Government and industry to assist academia in long term goals. This subtask area would conduct a workshop on software engineering education. A topic which could be discussed is the merit of including human factors types of courses within the Systems Engineer Curriculum. The subtask area would then establish software engineering university programs. Curriculum tailoring efforts should provide direction for academic institutions to capitalize on the Ada technology. A student funding program should provide a means for adding new expertise to the DoD.

2.2.4.2 Inputs. Trends in software engineering and computer science/engineering education are discussed in [3, 21, 27]. The impact of the Ada technology has been addressed in [10, 11]. Several authors [12, 13, 14] have addressed graduate software engineering education. Model curricula developed by the professional computing societies [1, 9, 17] should serve as input for tailoring to incorporate the Ada technology. The work of the Software Engineering Education Subcommittee of the IEEE Computer Society Model Curricula Subcommittee should be used as input for forming a model graduate curriculum in software engineering.

2.2.4.3 Description. The education programs subtask area is composed of four subtasks: 1) curricula, 2) evaluation, 3) selec-

tion, and 4) educational financial assistance program. The curricula subtask should conduct a workshop to establish the current extent of software engineering education. This workshop should be an excellent follow-on to the IEEE Computer Society sponsored Workshop on Software Engineering Technology Transfer, April 25-27, 1983, Miami Beach, Florida. The next phase of the curricula subtask would be to tailor existing professional society (ACM, DPMA, and IEEE Computer Society) curricula to incorporate Ada/APSE courses and software support. The military schools should provide input in the development of course syllabi.

The second subtask should be to evaluate, promulgate, and improve the tailored curricula. A distinguished panel of reviewers (DoD, industry, academia, and the professional computing societies should be formed to evaluate the curricula. The panel shold develop quantitative criteria to evaluate the established curricula. The review group would be maintained to improve the curricula and provide advice concerning implementation. The panel should report directly to the Embedded Computer Resources Board which is being formed under DoD Directive 5000.29.

The third subtask is to select and provide support to qualifying institutions to implement software engineering programs. There are currently three institutions offering M.S. degree programs in software engineering: Seattle University, Texas Christian University, and the Wang Institute of Graduate Studies. Approximately three software engineering programs should be supported per year starting in FY86. Criteria would be developed for evaluating university software engineering education program proposals. Hardware and personnel costs would constitute the major funding costs as the DoD will provide the software support (i.e., Ada and support environments).

The fourth subtask is to develop an eduational financial assistance program as an incentive for DoD personnel and for recruiting personnel. This subtask would increase existing ROTC scholarship funds for computer science and computer engineering majors. A fellowship program would be established for qualified DoD personnel to attend graduate programs in software engineering. A scholarship incentive program will be established for attracting qualified applicants to DoD civil service positions in software engineering. Finally, the possibility of student co-op, external, and intern programs would be investigated.

2.2.4.4 Coordination. The education program subtask area should interact with the career structures subtask area and the Software Engineering Institute.

2.2.4.5 Outputs. The proceedings of the software engineering education workshop should provide an assessment of the state-of-the-art and future directions for this area. Tailored model curricula would be produced for use in computer science and engineering programs. The review panel would provide recommendations and suggestions for institutions that plan to implement the tailored curricula. Finally, the DoD educational financial assistance program would increase the current level of DoD software-related manpower.

2.2.4.6 Cost Factors. The workshop and curricula tailoring efforts should be performed in a one year period. Funding for the review panel should be established. The establishment of software engineering academic programs should be funded for each academic program.

2.2.4.7 Benefit. This subtask area should provide tailored curricula that could be implemented by interested academic institutions. The objective of the curricula subtask is not to force acceptance of tailored curricula. It is a logical conclusion that the

advanced Ada technology be incorporated into academic programs. The tailored curricula and distinguished review panel serve as a means for assisting universities in utilizing the Ada technology. The establishment of software engineering education programs would increase the number of institutions that provide M.S. degree programs in software engineering. Finally, the educational financial assistance program would benefit DoD personnel and academic institutions.

2.2.4.8 Schedule. The milestone chart in Figure 2 indicates the front-end curriculum tailoring efforts which would be followed by the funding of the software engineering programs.

2.2.5 Training Programs

2.2.5.1 Purpose. This subtask area involves four major subtasks associated with support environments and non-academic software engineering and management courses. The first subtask would be a planning effort to assess the state-of-the-art in educational technology for software engineering. The second subtask would be a coordinating effort to assign organizations responsible for syllabi and course development. The third subtask would be to develop and deliver Ada courses. The final subtask would be to develop and deliver non-academic software engineering and management courses. These last two subtasks would be expected to provide a significant means for upgrading the software-related skills of DoD personnel.

2.2.5.2 Inputs. Pooch and Chattergy [20] discuss the continuing education aspects of computer science and engineering. An example of requirements formulation and analysis training as applied to junior grade Army officers is described in [25]. Wegner [28] includes an extensive survey of education efforts with the Ada technology. A two-day training session for the Higher Order Software, Inc. advanced approach to software engineering is discussed in [26].

Training techniques and military/industry training organizations for software-related subjects are also inputs to this subtask area.

2.2.5.3 Description. The first subtask should be to investigate existing knowledge delivery mechanisms: short courses/seminars, guidebooks, university-type courses, videotaped courses, satellite-based course presentation, and computer-aided instructional material. This subtask would investigate the industry approaches that are used in on-the-job and self-study course material for personnel with software-related skills. Finally, a long term effort would aim at advancing educational technology in software engineering. Finally, new knowledge delivery mechanisms would be investigated, e.g., computer-network based, computer-aided instructional material with video disc.

The second subtask should support the development of Software Engineering courses in university and military schools. A plan would be developed for the assignment of organizational responsibility in the administration and delivery of the developed courses. In addition, a plan would be developed for funding research efforts in new knowledge delivery mechanisms and for funding non-academic training. The Software Engineering Institute should provide input to the funding plan development effort.

The third and fourth subtasks should be the development and delivery of courses. DoD, industry, and academia should review the developed syllabi. The third subtask is concerned with Ada/APSE courses. The Software Engineering Institute should be responsible for monitoring the Ada/APSE course delivery. This role of the Software Engineering Institute is primarily one of maintaining quality control. The fourth subtask is concerned with non-academic courses for software engineering and management. Both subtasks would utilize existing knowledge delivery mechanisms that are identified in the first subtask. Both subtasks would plan to integrate new

knowledge delivery mechanisms that are developed through funding in the fourth subtask. Finally, a study would be performed to evaluate the impact of on-the-job and self-study course material on increased job performance.

2.2.5.4 Coordination. This subtask has coordination with the education program subtask area. Coordination with the measurement and human engineering task areas would be expected for evaluating the impact of the non-academic courses.

2.2.5.5 Outputs. The primary outputs of this subtask area are the Ada/MAPSE, support systems, and non-academic courses. Research in new knowledge delivery mechanisms is expected to aid in improving on-the-job and self-study course material.

2.2.5.6 Cost Factors. The front-end subtask on knowledge delivery mechanisms should be performed together with the Ada related course development and delivery. The non-academic course development delivery should also be funded.

2.2.5.7 Benefit. The major benefit of this subtask area is that educational tools would be provided to software engineers and managers. These educational tools are expected to be initially beneficial in upgrading the software skills of DoD personnel. As the non-academic course material progresses, this subtask is expected to aid in maintaining skills as advances are gained in software technology.

2.2.5.8 Schedule. The milestone chart in Figure 2 indicates the timeframes of the planning aspects of the first and second subtasks and the continuous nature of the third and fourth subtasks.

2.2.6 Learning Aids

2.2.6.1 Purpose. The learning aids subtask is concerned with automated instructional systems in software engineering. There are

three subtasks associated with this subtask area: 1) assign organizations responsible, 2) prepare initial RFPs, and 3) develop/evolve initial prototype. This subtask area would include advancing the state-of-the-art in knowledge-based systems for software engineering.

2.2.6.2 Inputs. The primary inputs for this subtask area consist of studies on advanced learning aids, knowledge-based systems, and human factors of software systems.

2.2.6.3 Description. The first subtask should be to establish a funding plan for advanced learning aids in software engineering. This funding plan should include knowledge-based systems. A plan should be developed for training the trainers of the Ada technology with the advanced learning aids. A list would be developed of organizations responsible for this subtask area.

The second subtask should be to survey existing educational technology and prepare initial RFPs for learning aids development. Criteria should be formulated for evaluating the RFPs. Initial RFPs should be based on rapid development of learning aids based on the integration of existing educational technology. Additional RFPs should be based on advanced state-of-the-art knowledge-based systems for software engineering.

The third subtask should be the development of an initial prototype. This prototype would evolve as user experience is gained with the system. An initial prototype would be located at the Software Engineering Institute. Access to the prototype should be provided to DoD organizations and knowledge-based system researchers. A software monitor should be incorporated within the initial prototype to evaluate user performance. These measures should be both qualitative and quantitative.

2.2.6.4 Coordination. This subtask area is expected to interact with the Software Engineering Institute, measurement, human engineering, and support systems task areas.

2.2.6.5 Outputs. Three outputs are expected from this subtask area. The funding of learning aids (including knowledge-based systems) is an initial output to be generated by this subtask area. An initial prototype would be accessible to the DoD community. Human factors aspects of the prototype would provide feedback for future systems development.

2.2.6.6 Cost Factors. The first subtask is expected to be performed in a nine month period. The second subtask should be performed in a six month period. The initial prototype, learning aids funding, and system measurement should also be funded.

2.2.6.7 Benefit. The primary benefit of this subtask area is an advancement in the state-of-the-art in software engineering learning aids. The area includes planning efforts for training educators to utilize the advanced learning aids in conjunction with the Ada technology.

2.2.6.8 Schedule. The milestone chart in Figure 2 indicates the concurrent nature of the planning and RFPs subtasks. These initial subtasks are followed by the subtask to develop an initial prototype with software monitoring capabilities. The third subtask also provides support for advanced learning aids.

4.0 OPPORTUNITIES

4.1 Upcoming Meetings in the Human Resources Area

A list of upcoming technical Conferences/Workshops/Symposia which should broaden the knowledge base of the Human Resources area are as follows:

IEEE Computer Society Workshop on Software Engineering Technology Transfer, Miami Beach, Florida, April 25-27, 1983;

1983 National Computer Conference, Anaheim, California, May 16-19, 1983;

1983 National Educational Computing Conference (NECC83), Baltimore, Maryland, June 6-8, 1983;

1983 Conference on Frontiers in Education, Worcester, Massachusetts, October 17-19, 1983;

IEEE Computer Society's Seventh International Computer Software and Applications Conference 1983 (COMPSAC83), Chicago, Illinois, November 7-11, 1983; and

Seventh International Conference on Software Engineering, Orlando, Florida, March 26-28, 1984.

4.2 Information Resources

This section includes two categories of information resources for the human factors task area. The first category includes previous studies [5, 7], bibliographies [18, 23], and reports [15, 16]. The second category includes technical journals and technical report providing organizations that should provide future information resources based on past experience:

Ada Letters;

Air Command & Staff College Reports;

Army Research Institute Reports;

Communications of the ACM;

Computer;

Computerworld;

Datamation;

Defense Management Journal;

Defense Systems Management College Reports;

Government Executive;

IBM Systems Journal;

IEEE Transactions on Education;

IEEE Transactions on Software Engineering;

Infotech State of the Art Reports;

Journal of Systems and Software;

Naval Postgraduate School Reports;

Naval Research Laboratory Reports;

NBS Special Publication Series 500-XX;

SIGCPR Newsletter;

SIGCSE Bulletin;

SIGPLAN Notices;

SIGSOFT Software Engineering Notes;

Software Practice and Experience; and

Springer-Verlag Lecture Notes in Computer Science.

These information sources should be periodically reviewed and entered into a human resources data base.

4.3 Current DoD and Non-DoD Activities

DoD Activities

Air Force Human Resources Laboratory - Ada Training Research & Development

Air Force Software Technology Transfer Center

National Academy of Sciences - Air Force Studies Board

Air Force effort to create "Embedded Computer Systems" Specialty Code.

Navy sponsored effort to establish Software Engineering G.S. Series.

Navy Office of Personnel Management Software Engineering Occupation Study

Non-Dod Activities

American Association of Engineering Societies recommendation for Federal Government effort in engineering faculty shortage

Bell Laboratories doctoral student fellowship program

Hewlett-Packard faculty investment through the Electronics Education Foundation of the American Electronics Association

Professional computing societies model curricula efforts

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